

**OPERATING CHARACTERISTICS AND
PERFORMANCE OF A HUMIDITY-
CONTROLLED VENTILATION SYSTEM,
PHASE 11: MONITORING AND
PERFORMANCE ANALYSIS**

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Mark Riley of Energy, Mines and Resources Canada developed the scope of work, supervised its execution, and thoroughly reviewed all stages of this project.

Laurent Jardinier and Pascal Teigne of CAN-AERECO Ventilation Inc. were responsible for material supply and installation of AERECO Humidity-Controlled Ventilation System in two houses. John Gusdorf of Sciometric installed and debugged the monitoring system.

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EXECUTIVE SUMMARY

The humidity-controlled ventilation systems rely on humidity levels generated by the occupants as being the controlling variable determining the necessary ventilation rate. In this way it attempts to follow a "demand-controlled ventilation" strategy (DCV): ventilate the house when and as needed.

The main objective of this project is to assess and evaluate the AERECO humidity-controlled ventilation system regarding its operating and performance characteristics, and particularly its ventilation effectiveness in typical Canadian houses. The field monitoring program was designed to gauge how well the ventilation system and the house respond to changes in indoor humidity. The system was installed in two single storey detached houses located near Ottawa, Ontario. These houses were monitored during the winter months of December 1989 to April 1990. Various operating parameters such as relative humidity, temperature, indoor/outdoor pressure difference, extractor flows, air inlet response, ambient conditions and energy consumption were continuously monitored using a computerized data acquisition system. Frequent field visits were made to ensure proper functioning of the system and the monitoring equipment.

The change in relative humidity due to occupancy is sensed by the air inlet, which responds to vary the fresh air supply. During normal occupancy, in most cases, relative humidity changes by 1 to 10%. The difference in estimated air flow due to such changes in RH, through the individual air inlet, varied from 0.8 L/s to a maximum of 1.7 L/s. The relative humidity levels did not appear to reflect the levels of normal human activity in any significant way during normal occupancy. However, AERECO air inlets (in its current configuration) showed quick response to sudden changes in occupancy (surge loads), increasing the air flow from 0.8 to 3.5 L/s in such surge load cases.

Carbon dioxide levels do appear to track human presence and levels of activity very well. A rise in CO₂ occurs consistently at times of maximum activity. CO₂ appears to be a good indicator of occupancy and indoor air quality in demand-controlled ventilation systems. With AERECO there is only a weak correlation between the occupancy (CO₂) and the response of air inlets. In both houses, the CO₂ levels in the master bedroom peaked at more than 1200 ppm and remained above this level for a period of three to seven hours during the night. It is probable, therefore, that the current air inlet system is not providing adequate fresh air supply. Since CO₂ appears to be a good indicator of occupancy, the demand-controlled ventilation systems, like AERECO, might require a combination of CO₂ and indoor relative humidity sensors to provide good air quality and moisture control in Canadian houses.

The in-flow and out-flow calculations showed the following results for both houses: The fresh air flow through air inlets varied from a minimum of 12% during non occupancy periods to a maximum of 27% of the total air flow during full occupancy. Estimated total air flow through all air inlets varied from 6.5 L/s to 16 L/s. Air leakage through the house envelope remained as the predominant component of fresh air supply.

In this regard, the air inlets are of questionable value except where the air leakage patterns are uneven and require additional leakage in specific applications.

The performance analysis of the exhaust system showed that continuous air exhaust was maintained adequately by the extractors. The flow measurements showed that these units were working according to their settings and on an average provided 47 L/s of exhaust in both houses. The total extractor flow varied from 18 L/s during unoccupied periods to 65 L/s during peak activities. These extractors kept the house depressurized by 3 to 7 Pa.

Energy efficiency is achieved with a DCV system by cutting back the fresh air provided to house occupants, ideally at times when it is not required by the house occupants. The results of air quality monitoring (CO₂) in both houses, however, raise questions about the suitability of humidity sensing as an exclusive demand control strategy for ventilation.

The AERECO system was effective in controlling condensation on windows in the house; however, the components need improvements to meet the minimum ventilation requirements as specified by the CSA Standard F326.

SOMMAIRE

Les systèmes de ventilation AERECO sont contrôlés par le niveau d'humidité généré par les occupants: la variable de contrôle qui détermine le débit de ventilation requis. Les concepteurs ont tenté de soumettre ces systèmes à une stratégie de ventilation contrôlée par la demande pour ne ventiler une maison qu'au besoin.

Le principal objectif de ce projet était d'évaluer les caractéristiques de fonctionnement et de rendement du système de ventilation AERECO, particulièrement en termes d'efficacité dans une maison canadienne type.

Un programme d'observation sur le terrain a été conçu pour évaluer à quel point le système de ventilation et la maison répondent bien à des changements d'humidité intérieure. Le système AERECO a été installé dans deux maisons unifamiliales d'un étage situées près d'Ottawa (Ontario). Les maisons ont été contrôlées d'avril 1989 à décembre 1990, durant les mois d'hiver. Divers paramètres de fonctionnement, dont l'humidité relative, la température, la différence de pression entre l'intérieur et l'extérieur, les débits d'évacuation, la réponse de la prise d'air, les conditions ambiantes et la consommation d'énergie, ont été contrôlés en continu au moyen d'un système informatisé de saisie des données. Des visites fréquentes ont été faites sur le terrain pour s'assurer du bon fonctionnement du système de ventilation et du matériel d'observation.

Le changement d'humidité relative en présence d'occupants est décelé par la prise d'air qui répond en variant l'alimentation en air frais. Le plus souvent pendant une occupation normale, l'humidité relative varie de un à dix pour 100. Le débit estimé dans les prises d'air a varié en fonction des changements d'humidité relative entre 0,8 et un maximum de 1,7 L/s. En cours d'occupation normale, l'humidité relative n'a pas semblé refléter le niveau d'activité humaine normale d'une manière manifeste. Cependant, dans leur configuration actuelle, les prises d'air du système AERECO ont présenté une réponse rapide à des changements soudains d'occupation, augmentant le débit d'air de 0,8 à 3,5 L/s pendant les charges de pointe.

Les niveaux de dioxyde de carbone (CO₂) semblent refléter très fidèlement la présence et l'activité humaines. Il y a toujours une élévation du niveau de CO₂ lorsque l'activité est maximale. Le CO₂ semble être un bon indicateur d'occupation et de qualité de l'air intérieur dans les systèmes de ventilation contrôlés par la demande. Cependant, dans le système AERECO, la corrélation est faible entre le niveau de CO₂ et la réponse des prises d'air. Dans les deux maisons, les niveaux de CO₂ dans la chambre des maîtres a

atteint un maximum de plus de 1200 ppm pendant une période de trois à sept heures la nuit. Il est donc probable que le système de prises d'air actuel n'assure pas une alimentation suffisante en air frais. Comme le CO₂ semble être un bon indicateur de l'occupation, les systèmes de ventilation contrôlés par la demande comme le système AERECO devraient peut-être être munis de capteurs de CO₂ et d'humidité relative intérieure pour assurer une bonne qualité de l'air et bien contrôler l'humidité. dans les maisons canadiennes.

Les calculs des débits d'entrée et de sortie ont révélé les résultats suivants pour les deux maisons. Le débit d'air frais dans les prises d'air a varié entre un minimum de 12 pour 100 pendant les période d'inoccupation et un maximum de 27 pour 100 du débit d'air total pendant la période de pleine occupation. Le débit d'air total estimé dans toutes les prises d'air a varié de 6,5 à 16 L/s. Les fuites d'air à travers l'enveloppe de la maison sont demeurées la principale cause d'alimentation en air frais. Par conséquent, les prises d'air sont de valeur discutable, sauf là où les fuites d'air sont mal réparties et sont insuffisantes dans des applications particulières.

Une analyse du rendement du système d'évacuation a montré qu'une évacuation en continu de l'air était correctement entretenue par les évacuateurs. Les mesures de débit ont révélé que ces appareils ont fonctionné conformément aux réglages et ont évacué 47 L/s en moyenne dans les deux maisons. Le débit total des évacuateurs a varié entre 18 L/s pendant les périodes d'inoccupation et 65 L/s pendant les périodes de pointe. Ces évacuateurs ont maintenu les maisons à une pression relative négative de 3 à 7 Pa.

L'efficacité énergétique du système de ventilation contrôlé par la demande tient aux coupures de l'alimentation en air frais, idéalement lorsque les occupants de la maison n'en ont pas besoin. Cependant, les résultats du contrôle de la qualité de l'air dans les deux maisons soulèvent des questions quant à la pertinence de la détection de l'humidité comme stratégie exclusive de contrôle de la ventilation par la demande. Même si le système AERECO a bien contrôlé la condensation dans les fenêtres de la maison, ses composantes ont besoin d'être améliorées pour satisfaire les exigences de ventilation minimales de la norme CSA F326.