

Indoor Air Quality in New California Homes with Mechanical Ventilation

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SUMMARY

The Healthy Efficient New Gas Homes (HENGH) study measured indoor air quality and mechanical ventilation use in 70 new California homes. This paper summarizes preliminary results collected from 42 homes. In addition to measurements of formaldehyde, nitrogen dioxide (NO₂), and PM_{2.5} that are discussed here, HENGH also monitored other indoor environmental parameters (e.g., CO₂) and indoor activities (e.g., cooking, fan use) using sensors and occupant logs. Each home was monitored for one week. Diagnostic tests were performed to characterize building envelope and duct leakage, and mechanical system airflow. Comparisons of indoor formaldehyde, NO₂, and PM_{2.5} with a prior California New Home Study (CNHS) (Offermann, 2009) suggest that contaminant levels are lower than measured from about 10 years ago. The role of mechanical ventilation on indoor contaminant levels will be evaluated.

KEYWORDS

Formaldehyde; nitrogen dioxide; particles; home performance; field study

1 INTRODUCTION

The HENGH field study (2016–2018) aimed to measure indoor air quality in 70 new California homes that have mechanical ventilation. Eligible houses were built in 2011 or later; had an operable whole-dwelling mechanical ventilation system; used natural gas for space heating, water heating, and/or cooking; and had no smoking in the home. Study participants were asked to rely on mechanical ventilation and avoid window use during the one-week monitoring period. All homes had a venting kitchen range hood or over the range microwave and bathroom exhaust fans. This paper presents summary results of formaldehyde, NO₂, and PM_{2.5} measurements in 42 homes. The full dataset is expected to be available in summer 2018.

2 METHODS

Integrated one-week concentrations of formaldehyde and NO_x were measured using SKC UME_x-100 and Ogawa passive samplers. Formaldehyde samplers were deployed in the main living space, master bedroom, and outdoors. PM_{2.5} were measured using a pair of photometers (ES-642/BT-645, MetOne Instruments) indoor in the main living space and outdoors. PM_{2.5} filter samples were collected using a co-located pDR-1500 (ThermoFisher) in a subset of the homes and time-resolved photometer data were adjusted using the gravimetric measurements. Results are compared with a prior field study CNHS (2007–2008) (Offermann, 2009) that monitored for contaminant concentrations over a 24-hour period in 108 homes built between 2002 and 2004, including a subset of 26 homes with whole-dwelling mechanical ventilation.

3 RESULTS

Figure 1 compares the indoor concentrations of formaldehyde, NO₂, and PM_{2.5} measured by the two studies. Results of HENGH are one-week averaged concentrations, whereas CHNS are 24-hour averages. HENGH measured lower indoor concentrations of formaldehyde and PM_{2.5}, compared to CNHS. For NO₂, the indoor concentrations measured by the two studies

are similar. Summary statistics of indoor and outdoor contaminant concentrations (mean and median concentrations; N=number of homes with available data) are presented in Table 1.

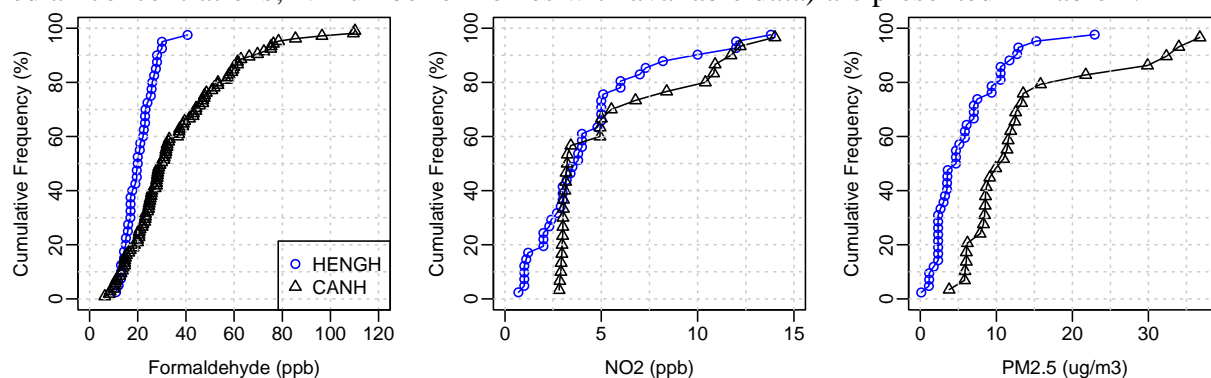


Figure 1. Comparisons of indoor contaminant concentrations measured by two studies.

Table 1. Summary statistics of indoor and outdoor contaminant concentrations.

| | HENGH - Indoor | | | CNHS - Indoor | | | HENGH - Outdoor | | | CNHS - Outdoor | | |
|--|----------------|--------|------|---------------|--------|------|-----------------|--------|------|----------------|--------|------|
| | N | Median | Mean | N | Median | Mean | N | Median | Mean | N | Median | Mean |
| Formaldehyde (ppb) | 39 | 20.0 | 20.6 | 104 | 29.5 | 36.3 | 38 | 2.0 | 2.0 | 43 | 1.8 | 2.8 |
| NO ₂ (ppb) | 40 | 3.7 | 4.4 | 29 | 3.2 | 5.4 | 40 | 3.0 | 3.1 | 11 | 3.1 | 3.5 |
| PM _{2.5} (ug/m ³) | 41 | 4.7 | 5.8 | 28 | 10.4 | 13.3 | 42 | 5.9 | 7.7 | 11 | 8.7 | 7.9 |

4 DISCUSSION

The lower formaldehyde concentrations measured by HENGH in comparison to CNHS may be attributable to California’s regulation to limit formaldehyde emissions from composite wood products that came into effect between the two studies. Gas cooking is a significant source of indoor NO₂ (Mullen et al., 2016). Even though NO₂ concentrations measured by HENGH are similar to levels found in CNHS, the two studies differed in that HENGH homes all use gas for cooking, whereas almost all homes (98%) from the prior study used electric ranges. More analysis is needed to determine the effectiveness of source control, such as range hood use during cooking, on indoor concentrations of cooking emissions such as NO₂ and PM_{2.5}. Lower PM_{2.5} indoors measured by HENGH compared to CNHS may be explained from a combination of lower outdoor PM_{2.5} levels, reduced particle penetration due to tighter building envelopes (Stephens and Siegel, 2012) combined with exhaust ventilation, and use of medium efficiency air filter (MERV 11 or better) in some HENGH homes. Further analysis of the data will evaluate the role of mechanical ventilation, including local exhaust and whole-dwelling ventilation system, on measured indoor contaminant levels.

5 CONCLUSIONS

New California homes now have lower indoor formaldehyde levels than previously measured, likely as a result of California’s formaldehyde emission standards. Indoor concentrations of NO₂ and PM_{2.5} measured are also low compared to a prior study of new homes in California.

ACKNOWLEDGEMENT

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6 REFERENCES

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