Reduction of Indoor Air Concentration of Formaldehyde by Adsorptive Polymer for Preventing Long Term Exposure Effects in Residences

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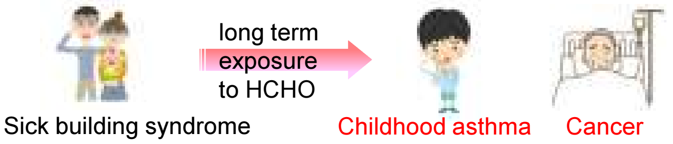
Introduction

In Japan, indoor air concentration of HCHO in newly-built houses has mostly become below the present IAQ guideline. However, considering adverse health effects caused by long term exposure to HCHO, further efforts should be required to reduce by using adsorptive materials. The purpose of this study is to demonstrate effective uses of the adsorptive polymer for the reduction of HCHO to outdoor levels.



Material

The adsorptive polymer (Grafton Inc., FXN-111-S6R) was made by a radiation induced graft polymerization. Mean molecular weight of the polymer was ~2000 g/mol.

adsorption mechanism

$$R-NH_2 + HCHO \rightarrow R-NCH_2 + H_2O$$

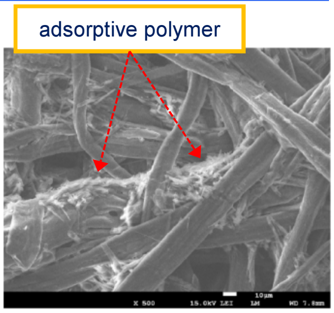


Fig.1 Electron microscope image of the adsorptive polymer(×500).

Methodologies

Laboratory test: Evaluating the removal performance small chamber tests were conducted for the vinyl cloth coated with the adsorptive polymer, following ISO16000-23 (Fig.2) HCHO concentrations at both outlets were simultaneously determined by a DNPH active sampler-HPLC methodology.

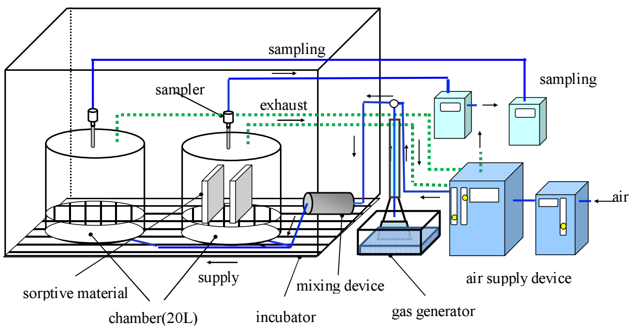


Fig.2 Schematic view of the small chamber system based on ISO16000-23

Field test: This were conducted at five newly multi-family houses in Japan (July 2013). The adsorptive polymer was coated on the vinyl cloth of ceiling of living room and bedroom. Room volume ranged from 20 to 53 m^3 with approx. 0.5 /h of ACH, and a loading factor was at 0.3 m^2/m^3. HCHO conc. were measured by a DNPH passive sampler – HPLC method before and after coating the polymer.

Laboratory Test

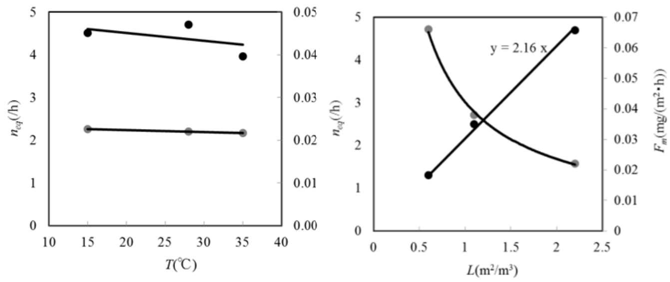


Fig. 3 Effects of temperature and loading factor on the sampling performance of the vinyl cloth coated with adsorptive polymer

Effects of temp. and R.H. were not significant on the sampling performance at least within the given ranges. While the equivalent air change rate n_{eq} increased proportional to the loading factor with a significant liner regression of y=2.16 x, r^2=0.997, the sorption flux decreased in inverse proportion to the loading factor.

Field Test

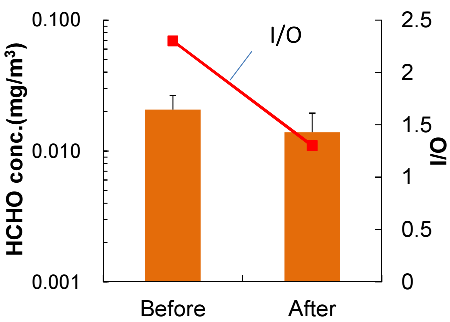


Fig.4 Comparison of mean HCHO conc. and I/O ratio before and after decorating the adsorptive polymer for ceiling of the ten rooms

Initial HCHO conc. in the ten rooms ranged from 0.013 to 0.031 mg/m^3 (mean 0.021 mg/m^3) with 1.4 ~ 3.4 of *I/O*. Although the values were much lower than the IAQ guideline set for the short term exposure to HCHO, the levels should be lowered as much as possible to prevent the long term exposure effects because residents wishes to live in the room for many years. After the decoration, the polymer significantly reduced the HCHO conc. ranging from 0.0058 ~ 0.026 mg/m^3 (mean 0.014 mg/m^3) with 0.4 ~ 1.9 of *I/O* ; in some rooms, the indoor conc. became below outdoor levels.

Conclusion

The field study showed the adsorptive polymer actually worked for reducing indoor HCHO concentrations to almost outdoor level, even when the initial concentrations were at the level much lower than the IAQ guideline.